INDOOR AIR QUALITY ASSESSMENT

Sky View Middle School
500 Kennedy Way
Leominster, MA 01453

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program

October 2005

Background/Introduction

At the request of the Leominster Health Department, the Massachusetts Department of Public Health's (MDPH) Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality at each of Leominster's public schools. These assessments were jointly coordinated through Chris Knuth, Director of the Leominster Health Department and David Wood, Facilities Director for Leominster Public Schools (LPS). On June 10, 2005 Sharon Lee an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program, conducted an assessment at the Sky View Middle School (SVMS), 500 Kennedy Drive, Leominster, Massachusetts.

The SVMS is a newly constructed red brick building completed circa 2003. The school contains general classrooms, science labs, special education rooms, computer room, library, the school nurse's office, cafeteria, kitchen, teachers' rooms, art room, music room, gymnasium and office space. Windows throughout the building are openable.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particulate matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). CEH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

This school houses approximately 750 students in grades 5 through 8, with approximately 90 staff members. Tests were taken during normal operations at the school. Results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were elevated above 800 parts per million (ppm) in six of sixty-eight areas, indicating adequate ventilation in the majority of areas surveyed. Fresh air in classrooms is supplied by unit ventilator (univent) systems (Picture 1). A univent draws air from outdoors through a fresh air intake located on the exterior wall of the building (Picture 2) and returns air through an air intake located at the base of the unit (Figure 1). Fresh and return air are mixed, filtered, heated and/or cooled and provided to classrooms through a diffuser located on the top of the unit. Adjustable louvers control the ratio of fresh and recirculated air. These univents do not have cooling capacities. Obstructions to airflow, such as furniture located in front of and/or materials stored on univents, were observed in some areas. In order for univents to provide fresh air as designed, these units must remain free of obstructions.

The mechanical exhaust ventilation system in classrooms consists of ceiling-mounted vents connected to rooftop fans (Pictures 3 and 4). This system was operating during the assessment. It is important to note that the location of some exhaust vents can limit exhaust efficiency. In some classrooms, exhaust vents are located above hallway doors (Picture 3). When classroom doors are open, exhaust vents will tend to draw air from both the hallway and the classroom. The open hallway door reduces the effectiveness of the exhaust vent to remove common environmental pollutants from classrooms.

Interior areas throughout the building are ventilated by rooftop air handling units (AHUs) (Picture 5). Fresh heated/cooled air is supplied through ceiling mounted air diffusers (Pictures 6 and 7) and ducted back to the AHUs via return vents.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room, while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The systems were reportedly balanced prior to occupation in 2005. In addition, Dave Wood, Facilities Director, reported that the LPS has a contract with Pioneer Valley Environmental, Inc., an engineering firm, for the company to conduct preventive maintenance on heating, ventilation and air-conditioning (HVAC) equipment in all of Leominster's public schools. The preventative maintenance program consists of an annual assessment of all HVAC system components (e.g., univents, AHUs, pneumatic controls, thermostats). A detailed report is generated and provided to the LPS facilities department to enable the LPS staff to address HVAC needs.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix A.

Temperature measurements ranged from 72^{o} F to 82^{o} F, many of which were above the MDPH recommended comfort range in a number of areas the day of the assessment. The temperature range measured at the time of assessment would be expected in a building where classrooms do not have an HVAC system with cooling abilities, outside temperature of 82^{o} F and open classroom windows. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. However, this is difficult to achieve without the aid of a mechanical cool air-conditioning system. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 51 to 78 percent, which was also above the MDPH recommended comfort range in a number of areas. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. While temperature is mainly a comfort issue, relative humidity in excess of 70 percent for extended periods of time can provide an environment for mold and fungal growth (ASHRAE, 1989). Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A few areas had water-stained ceiling tiles (Picture 8), most likely from water pooling on the roof in certain areas (Picture 9). Water-damaged ceiling tiles can provide a source for mold and should be replaced after a water leak is discovered and repaired. The freezing and thawing of water on a rooftop can lead to roof leaks and subsequent water penetration into the interior of the building. Pooling water can also become stagnant, which can lead to unpleasant odors and microbial growth. In addition, stagnant pools of water can serve as a breeding ground for mosquitoes.

Open seams between the sink countertop and backsplash were observed in several rooms (Picture 10). If not watertight, water can penetrate through the seam, causing water damage. Water penetration and chronic exposure of porous and wood-based materials can cause these materials to swell and show signs of water damage.

Several classrooms contained aquariums and terrariums. Aquariums should be properly maintained to prevent microbial/algae growth, which can emit unpleasant odors (Picture 11). Similarly, terrariums should be properly maintained to ensure soil does not become a source for mold growth.

Plants were noted in several areas. Plants, soil and drip pans can serve as sources of mold growth, and thus should be properly maintained. Plants should have drip pans to prevent wetting and subsequent mold colonization of window frames. Plants should also be located away from univents and ventilation sources to prevent aerosolization of dirt, pollen or mold (Picture 12).

Other IAQ Evaluations

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion products include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, BEHA staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels.

Outdoor carbon monoxide concentrations were non-detect or ND. Carbon monoxide levels measured in the school were also ND (Table 1).

As previously mentioned, the US EPA also established NAAQS for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standard requires outdoor air particulate levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, BEHA uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 46 $\mu g/m^3$. PM2.5 levels measured indoors ranged from 10 to 45 $\mu g/m^3$ (Table 1), which were below the NAAQS of 65 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were ND. Indoor TVOC measurements throughout the building were also ND (Table 1).

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC-containing products. While no measurable TVOC levels were detected in the indoor environment, VOC-containing materials were noted. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Cleaning products were found on countertops and beneath sinks in a number of classrooms. Cleaning products contain VOCs and other chemicals, which can be irritating to the eyes, nose and throat and should be stored properly and kept out of reach of students.

In several classrooms, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. Dust can be irritating to eyes, nose and respiratory tract.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made to improve general indoor air quality:

1. Remove all blockages from univents and exhaust vents.
2. Continue to operate both supply and exhaust ventilation continuously during periods of school occupancy. To maximize air exchange keep classroom doors closed.
3. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
4. Examine methods to improve drainage on the roof to prevent water pooling.
5. Ensure roof and/or plumbing leaks are repaired, and replace any remaining water-stained/missing ceiling tiles. Examine the space above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
6. Move plants away from univents in classrooms. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.

7. Clean and maintain aquariums and terrariums to prevent mold growth and associated odors.
8. Store cleaning products properly and out of reach of students.
9. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
10. Consider adopting the US EPA (2000b) document, "Tools for Schools", to maintain a good indoor air quality environment in the building. This document can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.
11. Refer to resource manuals and other related indoor air quality documents for additional building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website: http://mass.gov/dph/indoor_air.

References

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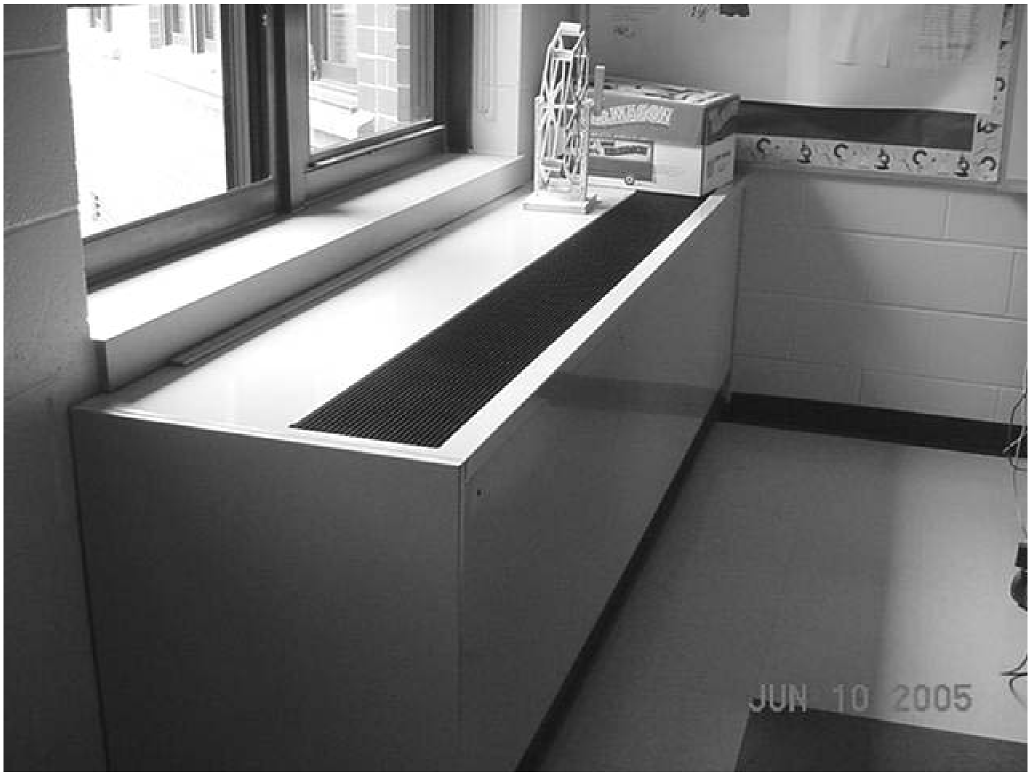
Picture 1



Classroom Univent

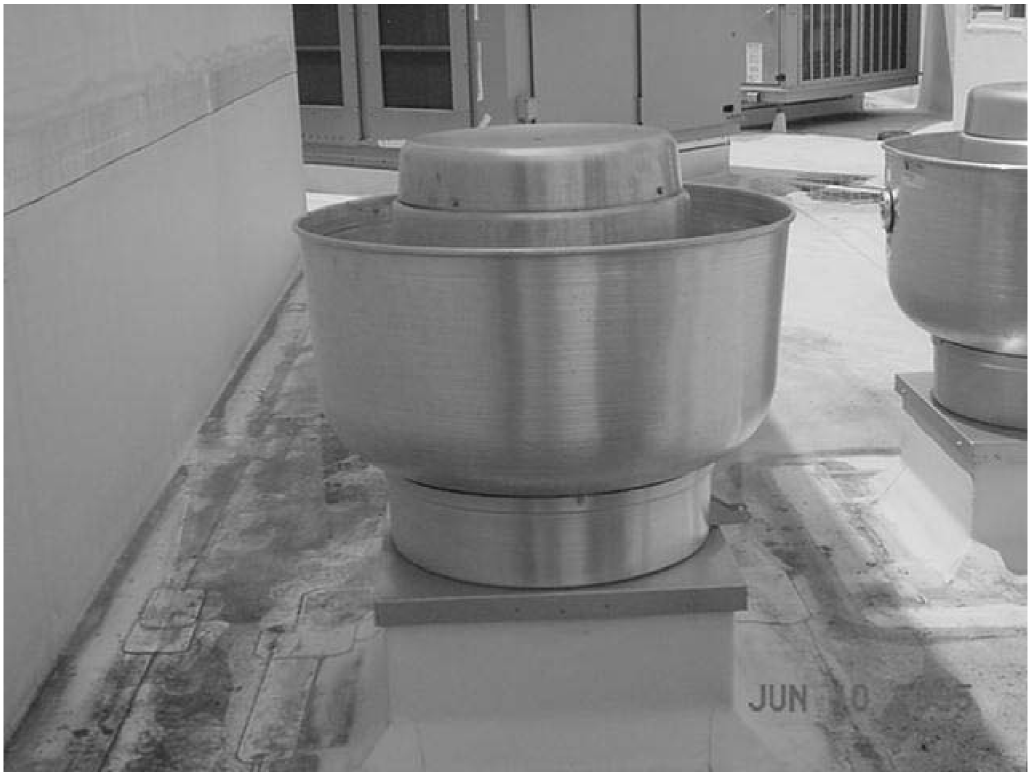
Picture 2

Univent Fresh Air Intake

Picture 3

Proximity of Classroom Exhaust Vent to Hallway Door

Picture 4



Rooftop Exhaust Motor

Picture 5

Rooftop AHU

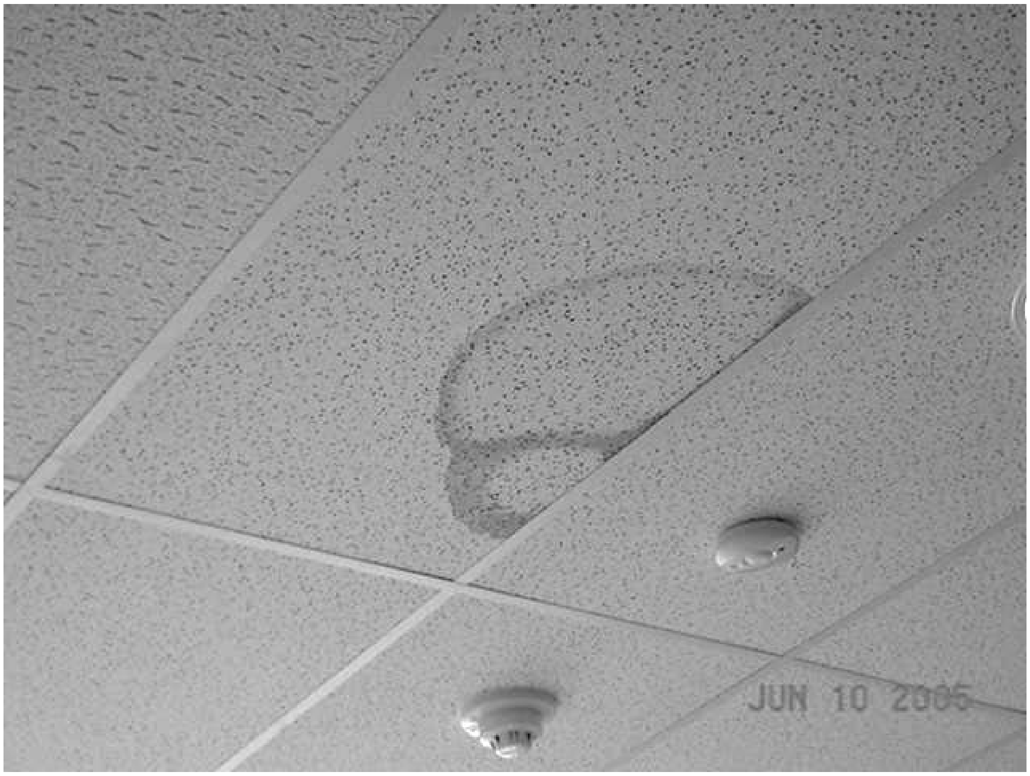
Picture 6

Ceiling-Mounted Directional Air Diffuser

Picture 7

Ceiling-Mounted Slotted Air Diffuser

Picture 8



Water Damaged Ceiling Tile

Picture 9

Pooling Water on Roof near AHUs

Picture 10

Seem Between Sink Countertop and Backsplash

Picture 11

Standing Water in Fish Tank hat is Green with Algal Growth

Picture 12

Plant on Paper Towel near Univent Air Diffuser

Sky View Middle School | **Indoor Air Results**

500 Kennedy Way, Leominster, MA 01453 | **Table 1** | **Date: 06/10/2005**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
background		82	70	403	ND	ND	46				Overcast, slight breeze.
Art	0	79	60	558	ND	ND	13	Y # open: 0 # total: 3	Y ceiling	Y ceiling	Cleaners, food use/storage, laminator.
cafeteria	200	74	62	692	ND	ND	23	N	Y ceiling	Y wall	Inter-room DO,
conference room	0	72	52	689	ND	ND	10	N	Y ceiling	Y ceiling	Inter-room DO, PF.
main office	3	74	61	621	ND	ND	12	N	Y ceiling	Y ceiling	Inter-room DO, PC.
media	27	74	57	556	ND	ND	21	N	Y wall	Y wall	34 computers.
teachers lounge	0	78	62	591	ND	ND	13	Y # open: 0 # total: 3	Y ceiling	Y ceiling	Laminator, plants, vending machine.
theatre	0	76	55	508	ND	ND	17	N	Y ceiling	Y ceiling	

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
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Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

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Table 1

Indoor Air Results
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Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
101 band/music	0	75	78	696	ND	ND	27	N	Y wall	Y ceiling	Inter-room DO, DEM.
105 gym	0	75	76	618	ND	ND	33	N	Y ceiling (weak)	Y wall (weak)	Inter-room DO,
107 weight room	0	77	74	516	ND	ND	42	N	Y ceiling	Y wall	rubber odors from new gym equip.
113	0	77	72	548	ND	ND	19	Y # open: 0 # total: 4	Y univent	Y ceiling	DEM.
120 staff lounge	2	72	53	708	ND	ND	10	N	Y ceiling	Y ceiling	Inter-room DO, plants.
126	1	72	51	678	ND	ND	10	Y # open: 0 # total: 2	Y univent	Y ceiling	Plants.
139	4	75	53	645	ND	ND	18	N	Y ceiling	Y ceiling	#WD-CT: 18, old leak.

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									Supply	Exhaust	
200	0	76	59	573	ND	ND	16	Y # open: 0 # total: 3	Y ceiling	Y ceiling	DEM.
201	1	79	60	566	ND	ND	12	Y # open: 0 # total: 4	Y ceiling	Y ceiling	Inter-room DO, DEM, items, plants.
202	0	78	52	578	ND	ND	14	Y # open: 2 # total: 2	Y ceiling	Y ceiling	Inter-room DO, DEM, items.
203	0	76	75	55	ND	ND	25	N	Y univent	Y ceiling location	Hallway DO, DEM.
205	20	78	74	547	ND	ND	26	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM.
206	1	78	75	424	ND	ND	28	Y # open: 2 # total: 4	Y univent	Y ceiling location	Hallway DO, 20 + students entering classroom.
207	0	78	73	584	ND	ND	27	N	Y univent	Y ceiling	Hallway DO, DEM.

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									Supply	Exhaust	
208	8	78	76	713	ND	ND	25	Y # open: 0 # total: 4	Y univent	Y ceiling	Hallway DO, DEM, dust.
209	5	79	74	659	ND	ND	30	Y # open: 3 # total: 4	Y univent items	Y ceiling location	Hallway DO, DEM.
210	20	79	74	617	ND	ND	28	Y # open: 4 # total: 4	Y univent items	Y ceiling location	DEM.
211	27	79	73	704	ND	ND	29	Y # open: 1 # total: 4	Y univent	Y ceiling location	Hallway DO, DEM, aqua/terra, plants, unlabelled products.
212	26	79	73	676	ND	ND	30	Y # open: 4 # total: 4	Y univent items	Y ceiling	Hallway DO, DEM, plants.
213	0	77	77	556	ND	ND	25	Y # open: 0 # total: 2	Y univent items plant(s)	Y ceiling	Hallway DO, WD-ceiling, DEM, items, plants.

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									Supply	Exhaust	
214	7	79	71	646	ND	ND	28	Y # open: 4 # total: 4	Y univent	Y ceiling	DEM.
304	0	81	67	636	ND	ND	32	Y # open: 4 # total: 4	Y univent plant(s)	Y ceiling location	Hallway DO, DEM.
305	25	81	69	704	ND	ND	32	Y # open: 2 # total: 4	Y univent	Y ceiling location	Hallway DO, Inter-room DO, DEM, PF, plants.
306	8	81	68	647	ND	ND	32	Y # open: 2 # total: 4	Y univent dust/debris plant(s)	Y ceiling location	Hallway DO, Inter-room DO, DEM, aqua/terra, cleaners, FC re-use.
307	20	81	68	561	ND	ND	37	Y # open: 3 # total: 4	Y univent items plant(s)	Y ceiling location	Hallway DO, DEM, PF, cleaners.
308	0	81	69	566	ND	ND	34	Y # open: 3 # total: 4	Y univent plant(s)	Y ceiling location	Hallway DO, DEM.

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309	19	79	71	606	ND	ND	31	Y # open: 4 # total: 4	Y univent	Y ceiling location	DEM, PF.
310	22	79	74	952	ND	ND	28	Y # open: 1 # total: 4	Y univent	Y ceiling location	DEM, PF, aqua/terra.
311	0	78	71	674	ND	ND	30	Y # open: 2 # total: 4	Y univent	Y ceiling location	Hallway DO, DEM.
312	22	77	78	1339	ND	ND	26	Y # open: 2 # total: 4	Y univent items	Y ceiling location	DEM, PF, items, FC re-use.
313	25	78	75	1128	ND	ND	28	Y # open: 0 # total: 2	Y univent	Y ceiling	DEM.
314	0	76	68	675	ND	ND	18	Y # open: 0 # total: 4	Y univent	Y ceiling location	DEM.
400	0	77	51	678	ND	ND	20	Y # open: 0 # total: 4	Y ceiling	Y ceiling	30 computers.

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile
NC = non-carpeted
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PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
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UF = upholstered furniture
VL = vent location
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Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Sky View Middle School

500 Kennedy Way, Leominster, MA 01453

Table 1

Indoor Air Results

Date: 06/10/2005

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
402	0	78	62	548	ND	ND	17	Y # open: 0 # total: 4	Y ceiling	Y ceiling	DEM.
403	21	78	72	743	ND	ND	45	Y # open: 2 # total: 3	Y univent items	Y ceiling	Hallway DO, Inter-room DO, DEM.
404	1	77	69	525	ND	ND	40	Y # open: 3 # total: 4	Y univent items	Y ceiling location	Hallway DO, DEM, cleaners, plants.
405	4	80	68	651	ND	ND	42	Y # open: 2 # total: 4	Y univent	Y ceiling location	Hallway DO, DEM, PF.
406	25	80	71	698	ND	ND	38	Y # open: 4 # total: 4	Y univent	Y ceiling location	
407	18	80	69	736	ND	ND	36	Y # open: 2 # total: 4	Y univent items	Y ceiling location	DEM, PF.
408	28	80	69	747	ND	ND	37	Y # open: 3 # total: 4	Y univent	Y ceiling location	Hallway DO, DEM, plants.

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Sky View Middle School | **Indoor Air Results**

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409	8	82	64	740	ND	ND	38	Y # open: 0 # total: 4	Y univent items	Y ceiling location	DEM, plants.
410	0	81	64	631	ND	ND	31	Y # open: 1 # total: 4	Y univent	Y ceiling location	DEM, PF.
411	15	82	64	748	ND	ND	40	Y # open: 1 # total: 4	Y univent items	Y ceiling location	Hallway DO, DEM, PF, items.
412	17	82	65	842	ND	ND	37	Y # open: 2 # total: 4	Y univent items	Y ceiling location	Hallway DO, DEM.
413	1	81	61	575	ND	ND	35	Y # open: 0 # total: 3	Y univent items	Y ceiling	
414	23	82	65	865	ND	ND	35	Y # open: 2 # total: 4	Y univent	Y ceiling location	Hallway DO, DEM.
500	0	79	60	576	ND	ND	16	Y # open: 0 # total: 4	Y ceiling	Y ceiling	

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	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
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Sky View Middle School **Indoor Air Results**

500 Kennedy Way, Leominster, MA 01453 **Table 1** **Date: 06/10/2005**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
502	0	79	59	600	ND	ND	18	Y # open: 0 # total: 4	Y ceiling	Y ceiling	23 computers.
502	0	80	65	458	ND	ND	27	Y # open: 0 # total: 2	Y univent	Y ceiling	DEM, aqua/terra, FC re-use, standing water in fish tank.
503	9	79	73	774	ND	1	36	Y # open: 0 # total: 0	Y univent	Y ceiling	Hallway DO, Inter-room DO, DEM, food use/storage.
504	1	81	63	562	ND	ND	28	Y # open: 4 # total: 4	Y univent (off)	Y ceiling	Hallway DO, DEM, PF, items hanging from CT, plants.
505	1	81	64	482	ND	ND	26	Y # open: 2 # total: 4	Y univent items plant(s)	Y ceiling location	Hallway DO, DEM, aqua/terra.
506	0	81	63	546	ND	ND	25	Y # open: 2 # total: 4	Y univent items	Y ceiling location	Hallway DO, DEM, PF, items.

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Indoor Air Results
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									Supply	Exhaust	
508	0	87	62	596	ND	ND	23	Y # open: 0 # total: 4	Y univent	Y ceiling location	DEM.
509	0	81	66	597	ND	ND	31	Y # open: 2 # total: 4	Y univent	Y ceiling location	DEM, PF, plants.
510	24	81	69	733	ND	ND	30	Y # open: 4 # total: 4	Y univent	Y ceiling location	Hallway DO, DEM, PF, plants.
511	24	81	67	625	ND	ND	28	Y # open: 3 # total: 4	Y univent	Y ceiling location	PF.
512	15	81	71	839	ND	ND	30	Y # open: 0 # total: 4	Y univent	Y ceiling location	Hallway DO, DEM, cleaners, items.
513	21	80	69	602	ND	ND	30	Y # open: 3 # total: 3	Y univent items plant(s)	Y ceiling	Hallway DO, DEM.

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									Supply	Exhaust	
514	0	82	67	628	ND	ND	29	Y # open: 3 # total: 4	Y univent	Y ceiling	Hallway DO, DEM, PS.
hallway near 525								N			#CT: 3, working with contractor to repair roof leak.
601	0	75	76	651	ND	ND	23	Y # open: 2 # total: 4	Y univent items	Y ceiling	

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µg/m3 = micrograms per cubic meter	BD = backdraft	FC = food container	ND = non detect	TB = tennis balls
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